BIOTECHNOLOGY

	FY 2023 Base Plan	FY 2024 (TBD)	FY 2025 Request
Biotechnology Funding[1] (Dollars in Millions)			
BIO	$148.00	-	$154.66
CISE	6.92	-	8.55
EDU	9.00	-	9.50
ENG	92.00	-	96.14
GEO Programs	10.00	-	10.45
GEO: OPP	1.60	-	1.67
MPS	62.20	-	67.20
SBE	1.50	-	1.57
TIP	52.58	-	70.44
IA	1.00	-	1.00
Total	**$384.80**	**-**	**$421.18**

[1] Funding displayed may have overlap with other topics and programs.

Overview

Since the first genetic engineering experiments over 50 years ago, the U.S. has become a world leader in biotechnology with resulting products contributing over $900 billion in economic activity, approximately 5 percent of the U.S. GDP, in recent years.[1] Biotechnology comprises the data, tools, research infrastructure, workforce capacity, and innovation that enable the discovery, use, and reprogramming of living organisms, their constituent components, and their biologically related processes. Advances in biotechnology areas include genome sequencing, editing, and synthesis; synthetic and engineered biology; chemical biology and chemical genetics; imaging and biosensing; and computational methods including artificial intelligence data management and maintenance, and biomolecule structure prediction. This also includes bio-related approaches from engineering, mathematics, physical sciences, and computational sciences, which are spurring rapid development of capabilities in biotechnology that drive innovation for the U.S. bioeconomy. These capabilities also deliver solutions to societal challenges such as climate change and infectious disease, among others, and provide the foundational and use-inspired research that will lead to the creation of data, information, goods and services that contribute to the agriculture, health, security, manufacturing, energy, and environmental sectors of the United States.

NSF has long supported the breadth of fundamental and translational research that catalyzes the development of biotechnology. Current investments—from programs in almost every directorate—include research and infrastructure encompassing studies across scales; from the molecular to the

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[1] Public and Private Funding Opportunities to Advance a Circular US Bioeconomy and Maintain U.S. Biotechnology Competitiveness, Interim Report of Schmidt Futures Bioeconomy Task Force, 2021.

organism and ecosystem, and from foundational to translational, carried out by individual investigators, teams, and multi-institutional centers. NSF also invests in educational programs to prepare and empower a workforce to support U.S. needs in biotechnology, and NSF funds research on the ethical, social, legal, economic, and environmental consequences of synthetic biology and other biotechnologies that contribute to public understanding and socially responsible use. These investments enable biotechnology innovations that not only address societal problems, such as health, climate change, food security, and clean energy, but also promote development of a robust supply chain of biologically derived materials needed to ensure U.S. resilience to global interruptions. Biotechnology promises to enable new modes of computation, including for information storage, retrieval, and processing; foods and feedstocks that will provide raw materials for new bioindustries; new organs and organisms engineered for multiple purposes, technologies capable of sensing emerging infectious agents; self-healing materials for sustainable infrastructure; and other heretofore unimagined products, processes and technologies inspired by, or developed with, living systems. Biotechnology advances will enable novel predictive tools and platform technologies to empower the U.S. to react rapidly to new and emerging biological threats, to address economic and societal challenges, and to respond with solutions for unanticipated challenges.

NSF has responded to reports from the Office of Science and Technology Policy (OSTP),[2] the National Academies,[3] and the Government Accountability Office,[4] to lead and coordinate interagency activities that promote synthetic biology and develop next-generation tools to advance biotechnology. NSF has continued to lead the way in funding foundational and use inspired research in synthetic and engineering biology as well as efforts to advance our understanding and practice of societal, ethical, and environmental issues associated with the field, as called for in the CHIPS and Science Act of 2022.[5] NSF has also worked collaboratively across the U.S. Government in response to Executive Order 14081,[6] Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe and Secure American Bioeconomy, to produce reports that highlight research and development,[7] data,[8] biomanufacturing, workforce,[9] and international needs and opportunities.

New NSF investments in FY 2023 aimed at biotechnology innovation included programs for: Biofoundries to Enable Access to Infrastructure and Resources for Advancing Modern Biology and Biotechnology (Biofoundries); Using Rules of Life to Address Societal Challenges; Building Synthetic Communities for Biology, Mitigating Climate Change, Sustainability, and Biotechnology (Synthetic Communities), Bioinspired Design Collaborations to Accelerate the Discovery-Translation Process (BioDesign), a new BioInspired Design Track in the Convergence Accelerator, Molecular Foundations for Biotechnology (MFB) Partnerships to Transform Emerging Industries – RNA Tools/Biotechnology,

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[2] https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/national_bioeconomy_blueprint_april_2012.pdf

[3] www.nationalacademies.org/our-work/safeguarding-the-bioeconomy-finding-strategies-for-understanding-evaluating-and-protecting-the-bioeconomy-while-sustaining-innovation-and-growth

[4] www.gao.gov/products/gao-18-656

[5] www.congress.gov/117/plaws/publ167/PLAW-117publ167.pdf

[6] Executive Order on Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe, and Secure American Bioeconomy | The White House

[7] Bold Goals for U.S. Biotechnology and Biomanufacturing: Harnessing Research and Development to Further Societal Goals (whitehouse.gov)

[8] Vision, Needs, and Proposed Actions for Data for the Bioeconomy Initiative (whitehouse.gov)

[9] Building-the-Bioworkforce-of-the-Future.pdf (whitehouse.gov)

and Global Centers: Use-Inspired Research Addressing Global Challenges in Climate Change and Clean Energy. Just announced, the FY 2024 topic for Global Centers is Bioeconomy. The FY 2024 Bioeconomy Global Centers will fund international centers, in collaboration with several international partners, to address research and development needs[10] critical to addressing the societally important goals of the bioeconomy. These new investments build on prior and continuing investments such as Accelerating Innovations in Biomanufacturing Approaches through Collaboration between NSF and the DOE Bioenergy Technologies Office-funded Agile BioFoundry; EFRI: Engineering Living Systems; EFRI: Brain-inspired Dynamics for Engineering Energy-Efficient Circuits and Artificial Intelligence; Sentinel Cells for Surveillance and Response to Emergent Infectious Diseases; Enabling Discovery Through Genomics; Future Manufacturing; and Materials Innovation Platforms. They also build on investments at the intersection of biotechnology, artificial intelligence, and quantum sciences through the National Artificial Intelligence Research Institutes and Quantum Leap Challenge Institutes programs. New awards made in FY 2023 through the NSF Regional Innovation Engines program, as well as the Science and Technology and Engineering Research Centers programs, include awards focused on biotechnology research, innovation, and translation. A pilot partnership with NobleReach Emerge further expands on opportunities to translate advances in NSF funded biotechnology via collaboration with commercialization experts. Together, these new investments complement core programs in research, infrastructure, workforce development and translation that advance U.S. competitiveness and leadership in biotechnology and the bioeconomy.

Goals

1. *Fundamental Research:* Support foundational and use-inspired research in science and engineering that will fuel innovations in biotechnology, as articulated in recent reports.
2. *Computing and Physical Infrastructure*: Develop the computing and physical infrastructure necessary to generate fundamental knowledge and advance accompanying biotechnology. These investments will reflect the vision for data and AI reflected in recent reports and executive orders.[11]
3. *Proof-of-Concept Advances and Testbeds*: Deliver proof-of-concept processes, devices, bio-based robots (biobots), applications, tools, and systems that integrate fundamental science and engineering and translational research to exploit emerging biotechnological advances for scientific and societal benefit.
4. *Education and Workforce Development*: Empower the full spectrum of U.S. talent to achieve the above goals and to generate biotechnology literate workers who will implement the results of these breakthroughs.

FY 2025 Investments

Fundamental Research
NSF will continue its support in the discovery of fundamental biological principles and the development of biotechnologies and other tools that permit measurement and use-inspired manipulation and design of living systems and their components. New interdisciplinary partnerships

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[10] Bold Goals for U.S. Biotechnology and Biomanufacturing: Harnessing Research and Development to Further Societal Goals (whitehouse.gov)
[11] Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence | The White House

across the agency will motivate bio-inspired design and stimulate use-inspired solutions, including levering innovations from evolution across the Tree of Life.[12]

Computing and Physical Infrastructure

NSF will continue to invest in bioinformatics, computational biology, bio-based computing devices, and artificial intelligence to support biotechnology advancements. Two new synthesis centers in molecular and cellular biosciences and organismal biosciences will enable data synthesis and reuse for biological understanding and biotechnology design. New investments in biotechnology data infrastructure will align with and leverage the National Artificial Intelligence Research Resource (NAIRR).[13] NSF will also leverage distributed networks of biofoundries, supported in part through NSF's new Biofoundries program, and regional mid-scale facilities–to support growth of U.S. biotechnology innovation.

Proof-of-Concept and Testbed Development

Sustained support for synthetic and engineering biology as a pillar of biotechnology will accelerate the design-build-test-learn cycle and leverage bio-inspired design to develop bio-machines, biobots, and biomanufacturing technologies to address many of today's challenges. New investments in testbeds, in pilot programs to enhance translation of NSF funded research, and in regional innovation will expand participation within the bioeconomy and accelerate the translation of biotechnology to solve societal problems.

Education and Workforce Development

To prepare a diverse biotechnological workforce, NSF will invest through programs such as the Advanced Technological Education program at two-year institutions, sites and supplements for Research Experiences for Undergraduates and Research Experiences for Teachers, and the NSF Research Traineeship Program that prepares graduate students to conduct research in convergent areas and acquire skills that allow them to succeed in diverse employment settings. NSF will also support training at the postdoctoral and early-career level through fellowships and participation in the NSF Innovation Corps (I-Corps™) program, to enable scientists and engineers to further the societal benefits of their work. Finally, through the Experiential Learning for Emerging and Novel Technologies (ExLENT) program, NSF will invest in today's workforce, providing opportunities for individuals to pivot into biotechnology jobs.

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[12] LIFE: Leveraging Innovations From Evolution Town Hall | NSF - National Science Foundation

[13] Strengthening and Democratizing the U.S. Artificial Intelligence Innovation Ecosystem: An Implementation Plan for a National Artificial Intelligence Research Resource (nsf.gov)